US005803437A

United States Patent [19]

Paterson et al.

[11] **Patent Number: 5,803,437**

[45] **Date of Patent: Sep. 8, 1998**

[54] **CHAINLESS DRIVE WINCH**

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[21] Appl. No.: **824,156**

[22] Filed: **Mar. 26, 1997**

[51] **Int. Cl.**[6] **B66D 1/00**

[52] **U.S. Cl.** **254/343**; 254/378; 254/333; 254/335; 254/276

[58] **Field of Search** 254/343, 378, 254/276, 333, 335

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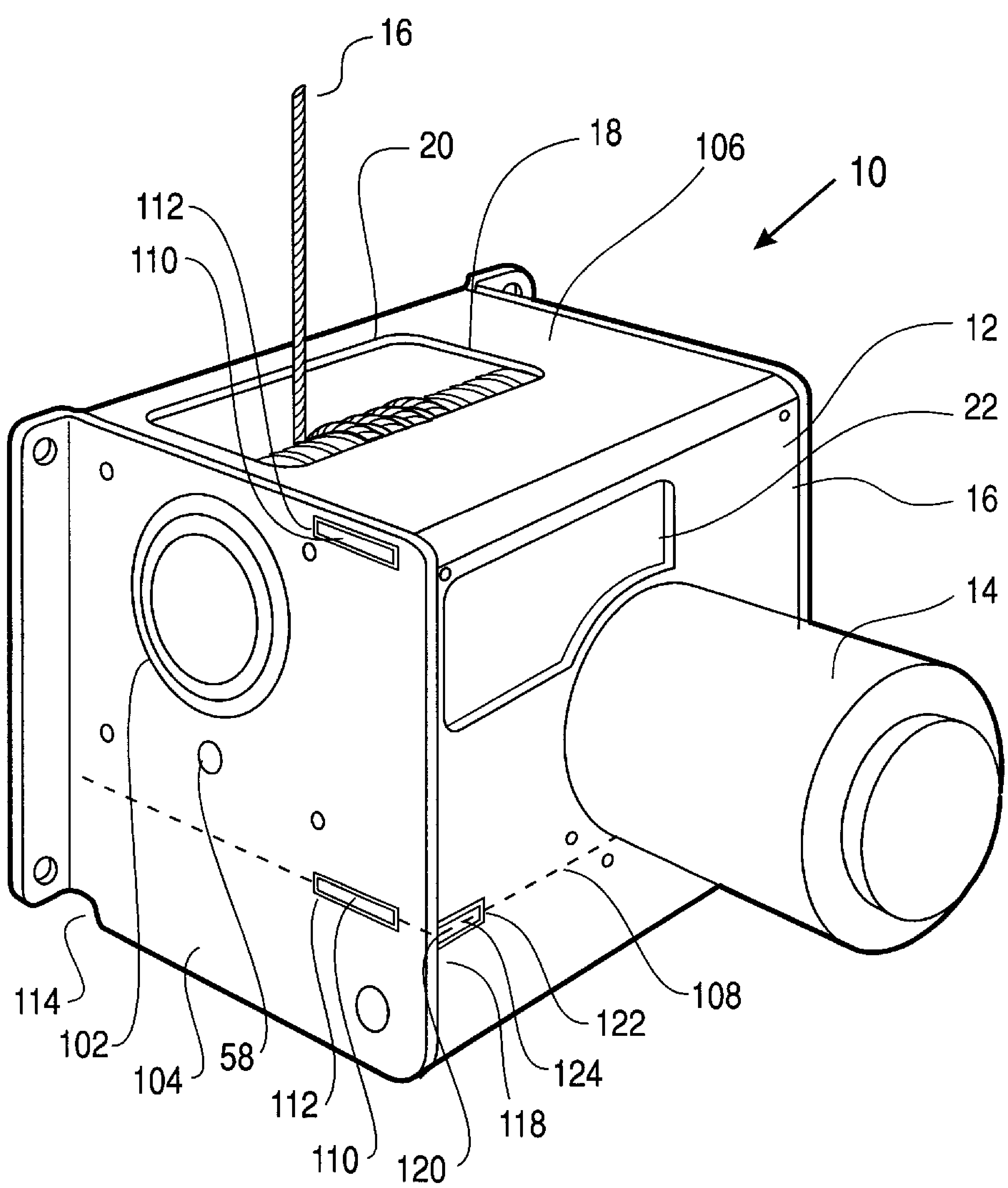
[57] **ABSTRACT**

A chainless drive winch is provided having a cable cylinder meshing with an orthogonal, cylindrical reduction gearing member. The reduction gearing member may be driven by, for example, an electric motor. A brake is provided operable only when the reduction gearing member is rotated is a direction to lower a load. Limit switches may be provided which are adjustable to alter the distance between them. A trigger finger moving between the limit switches is driven from the cable cylinder. The cable cylinder may be provided with a generally parallel roller to hold turns of cable on the cylinder. The roller may be independently biased at each end so that, when cable is partially unwound from the cylinder, the bias of the roller is enhanced on the remaining turns.

20 Claims, 8 Drawing Sheets



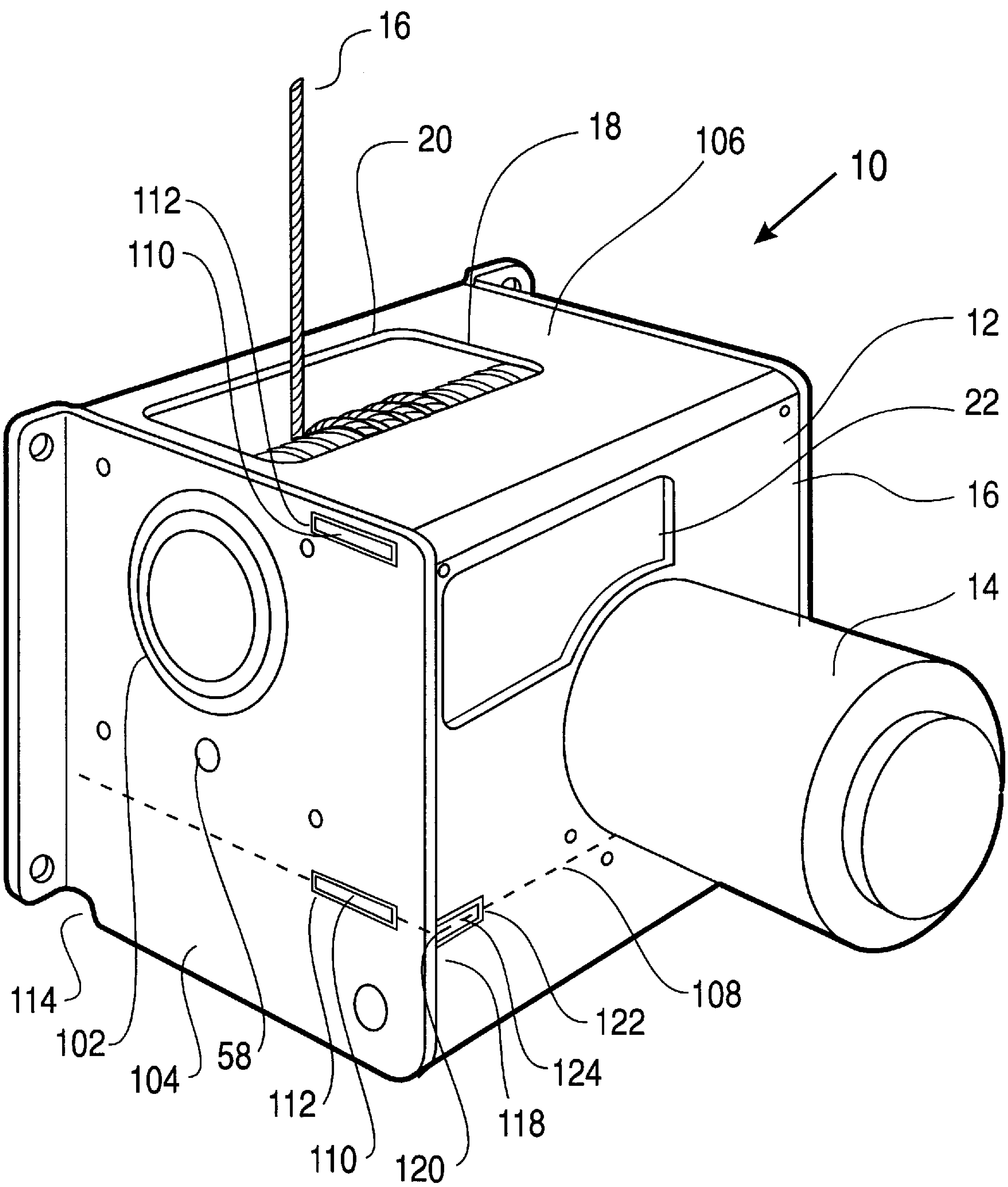

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FIGURE 1

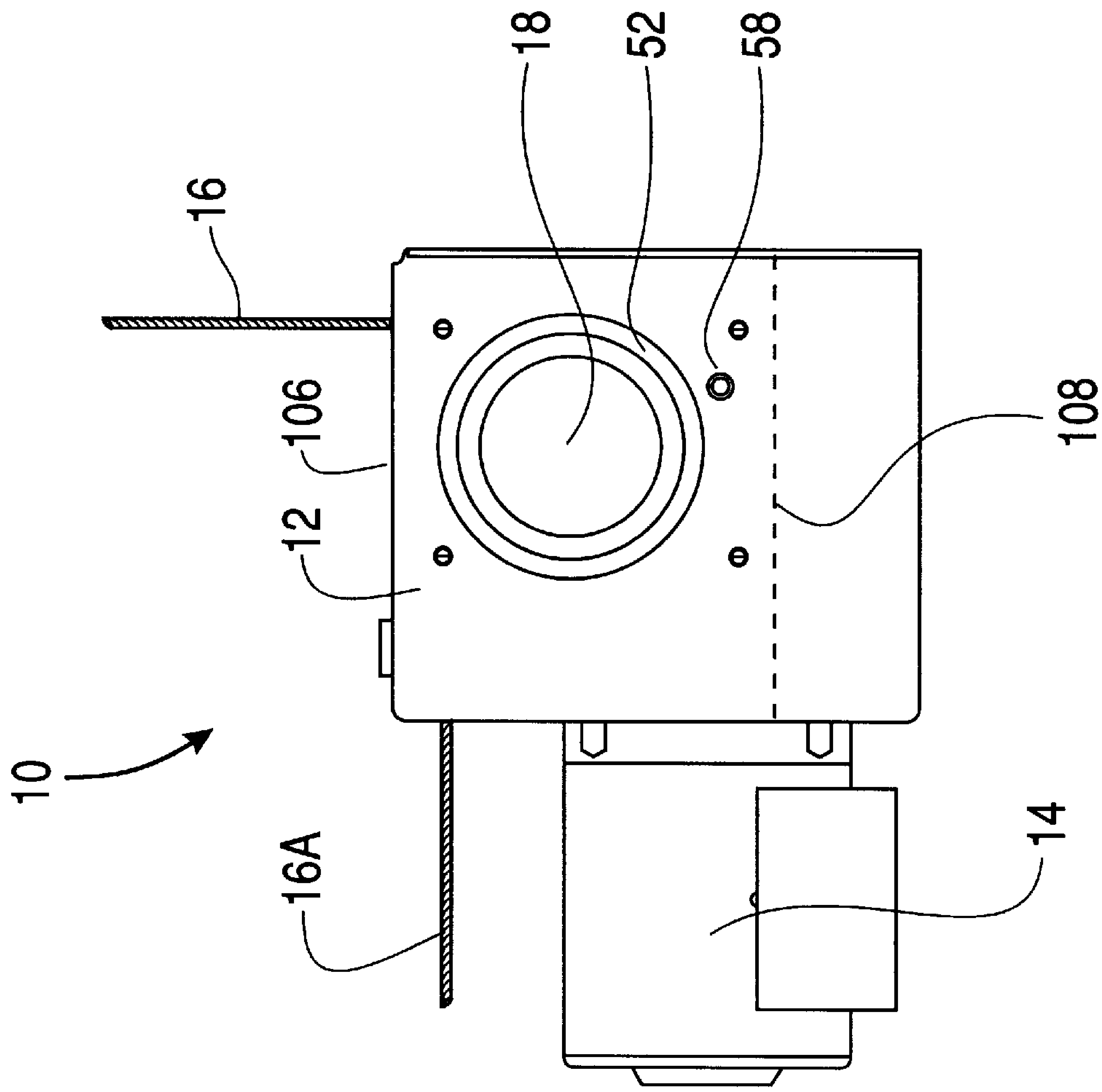

FIGURE 3

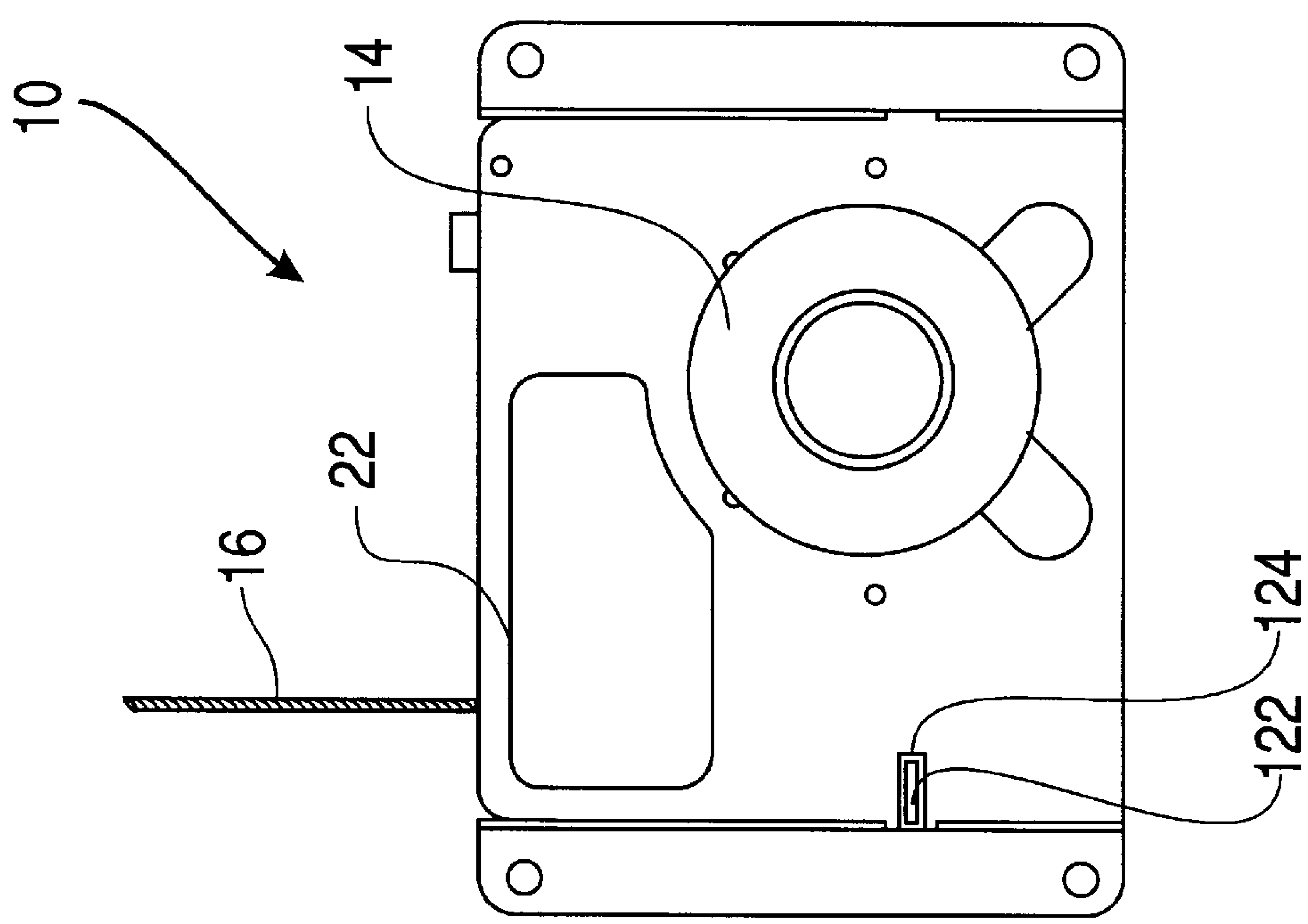

FIGURE 2

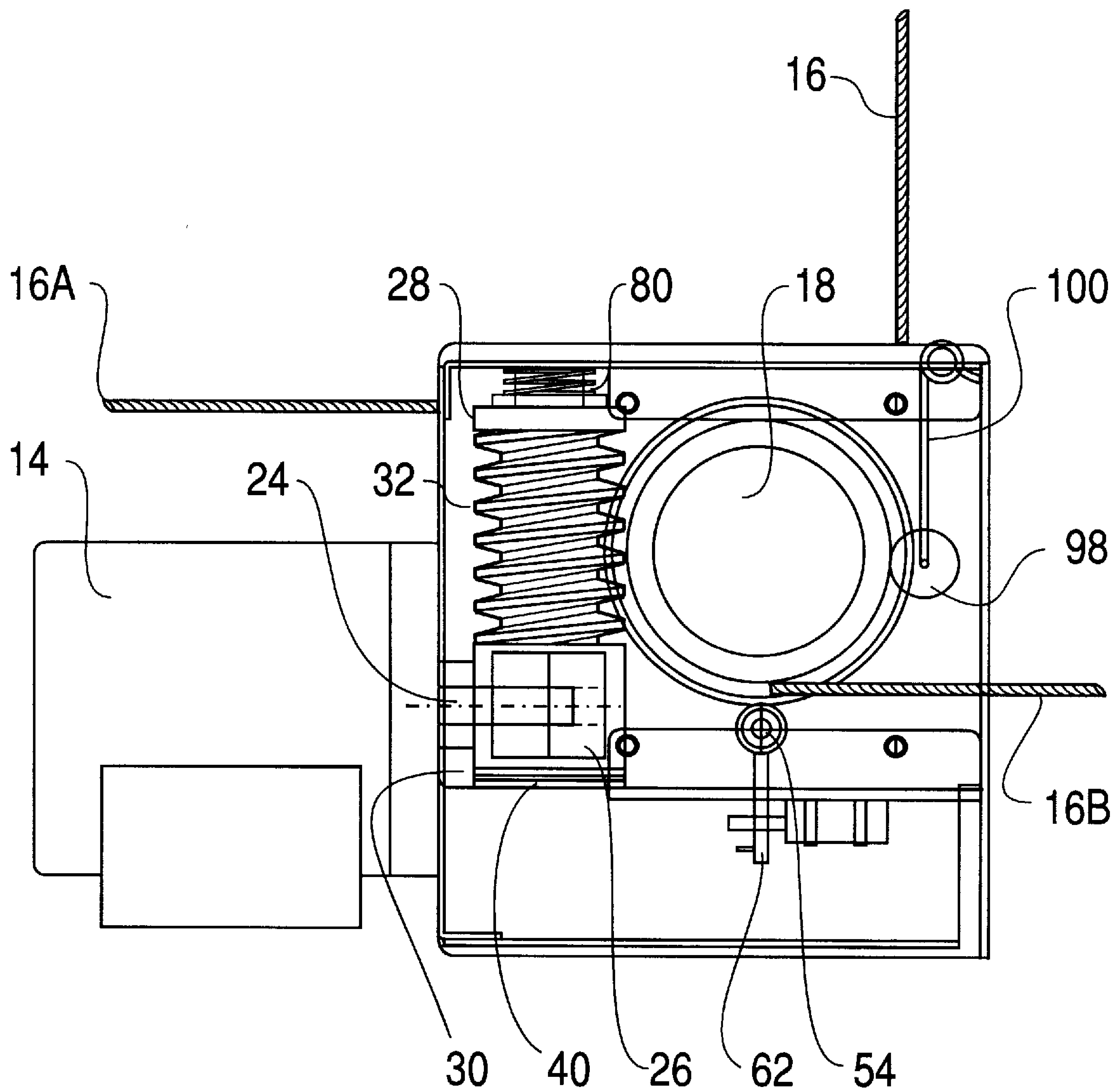

FIGURE 4

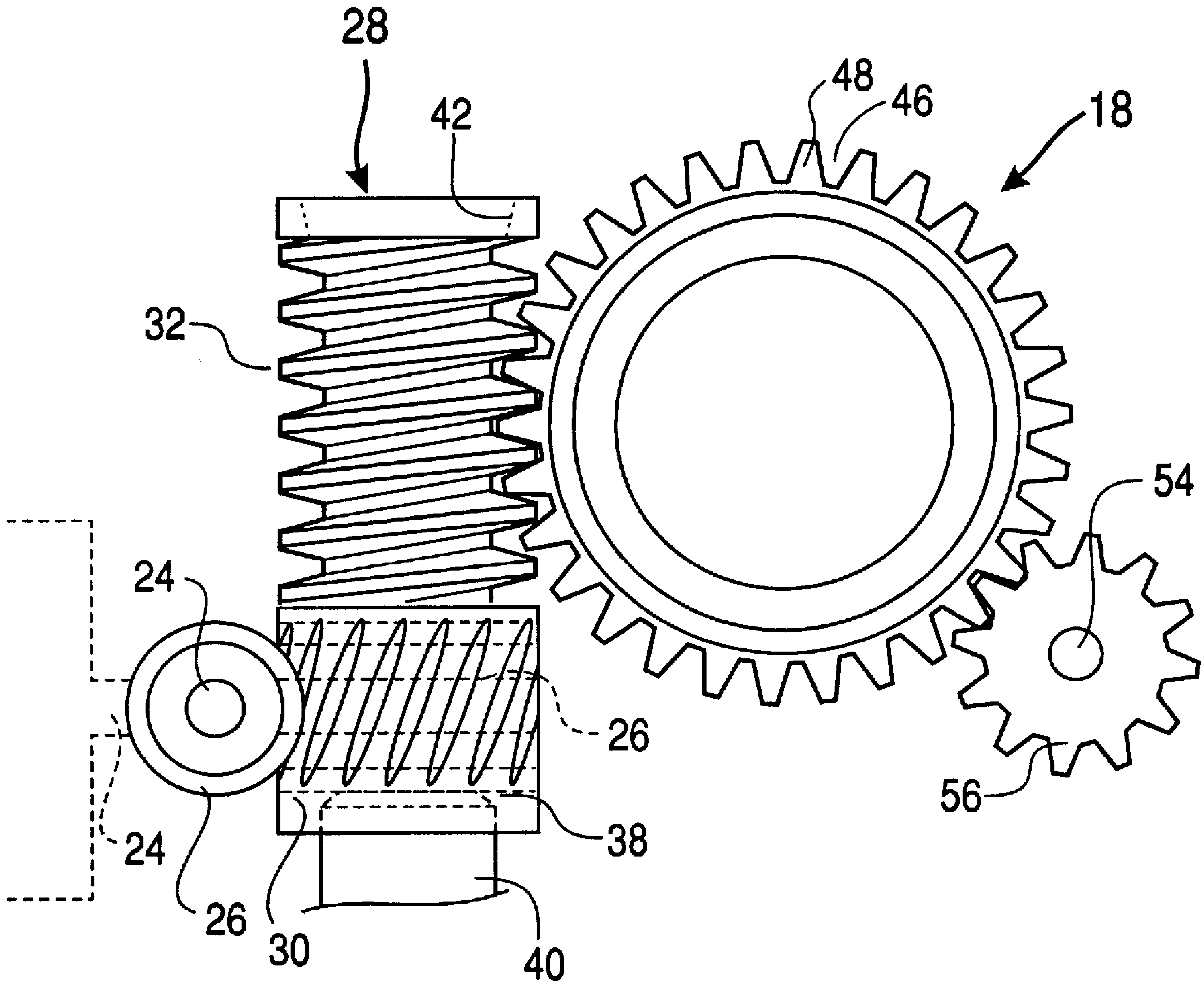

FIGURE 5

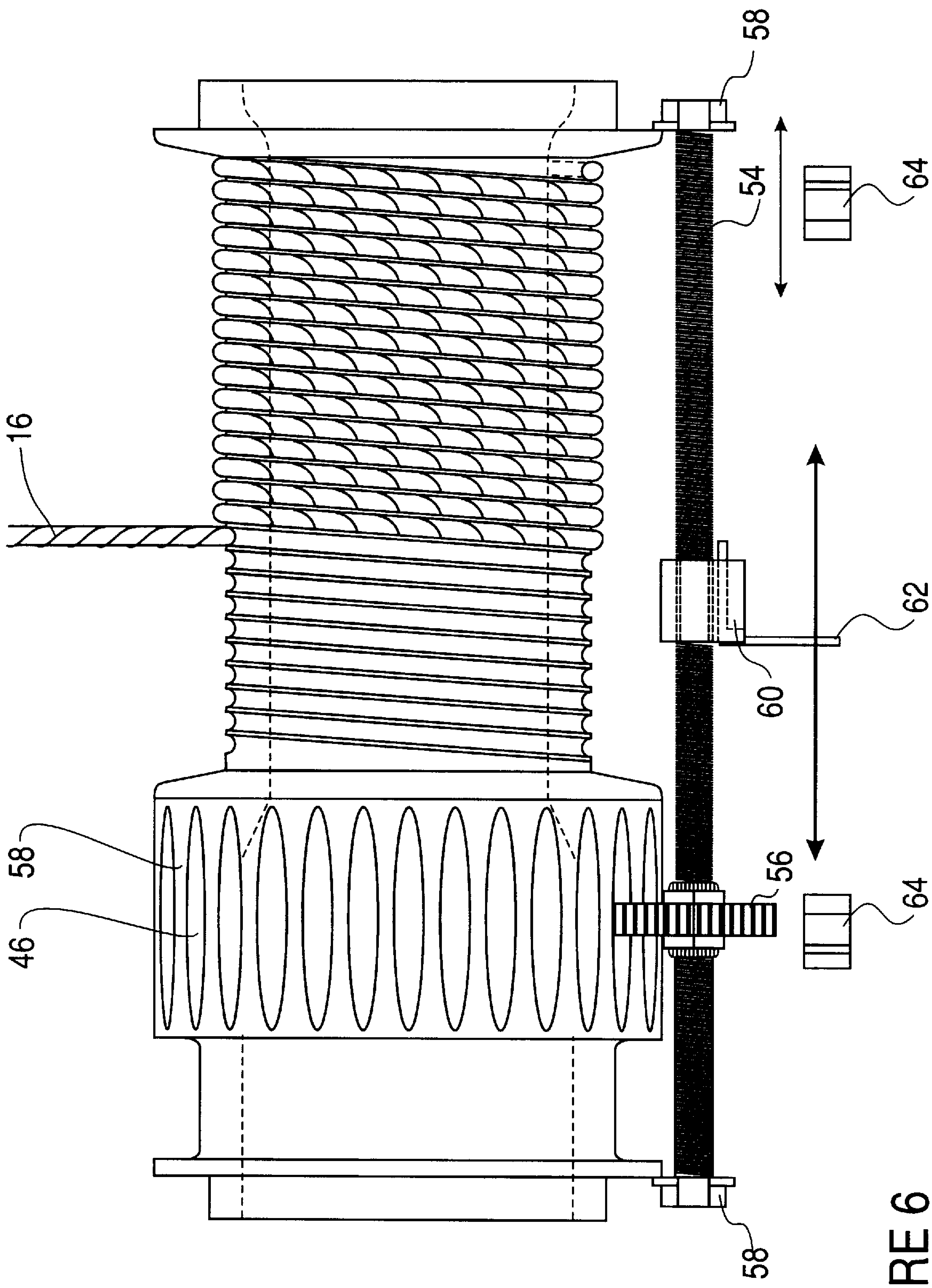

FIGURE 6

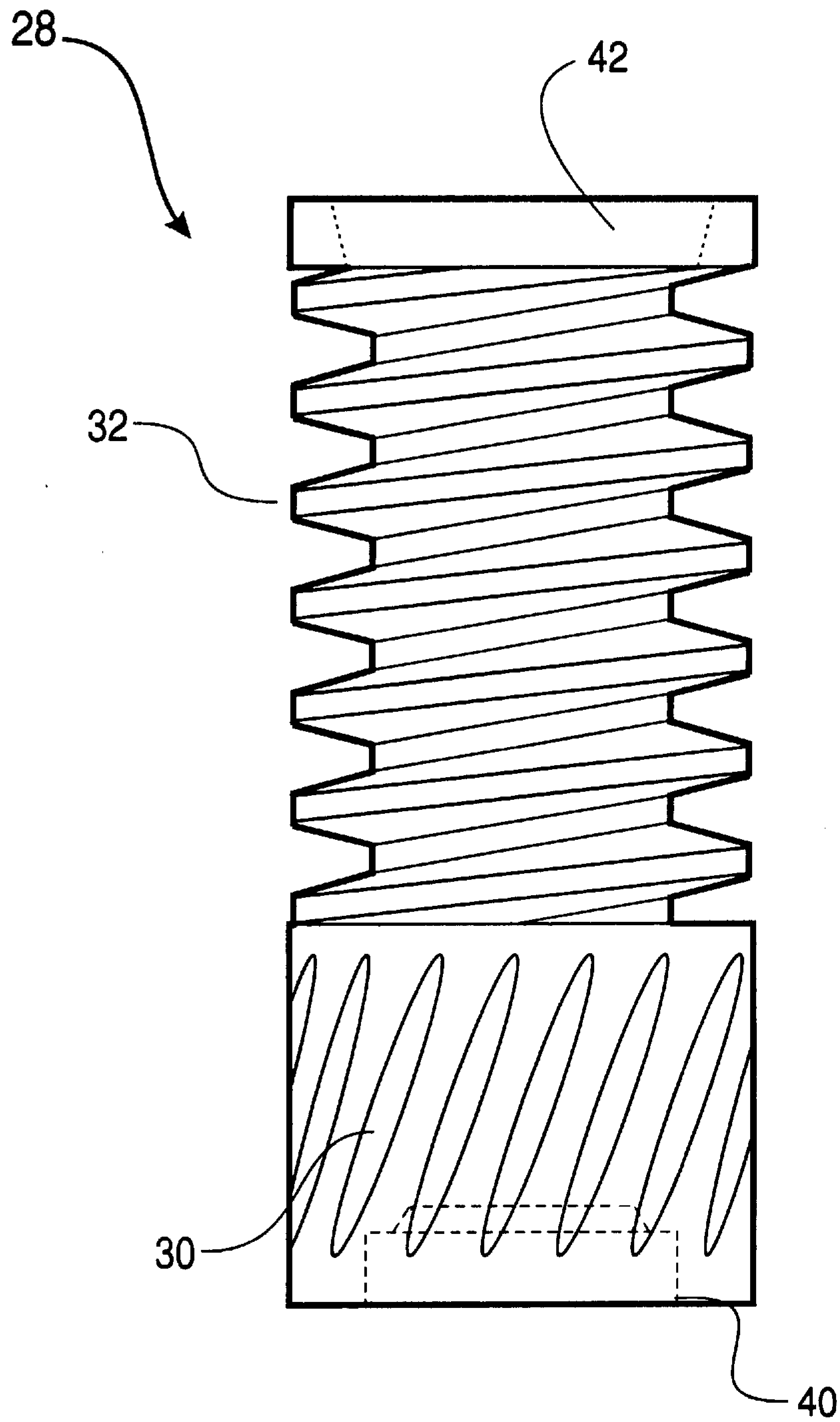

FIGURE 7

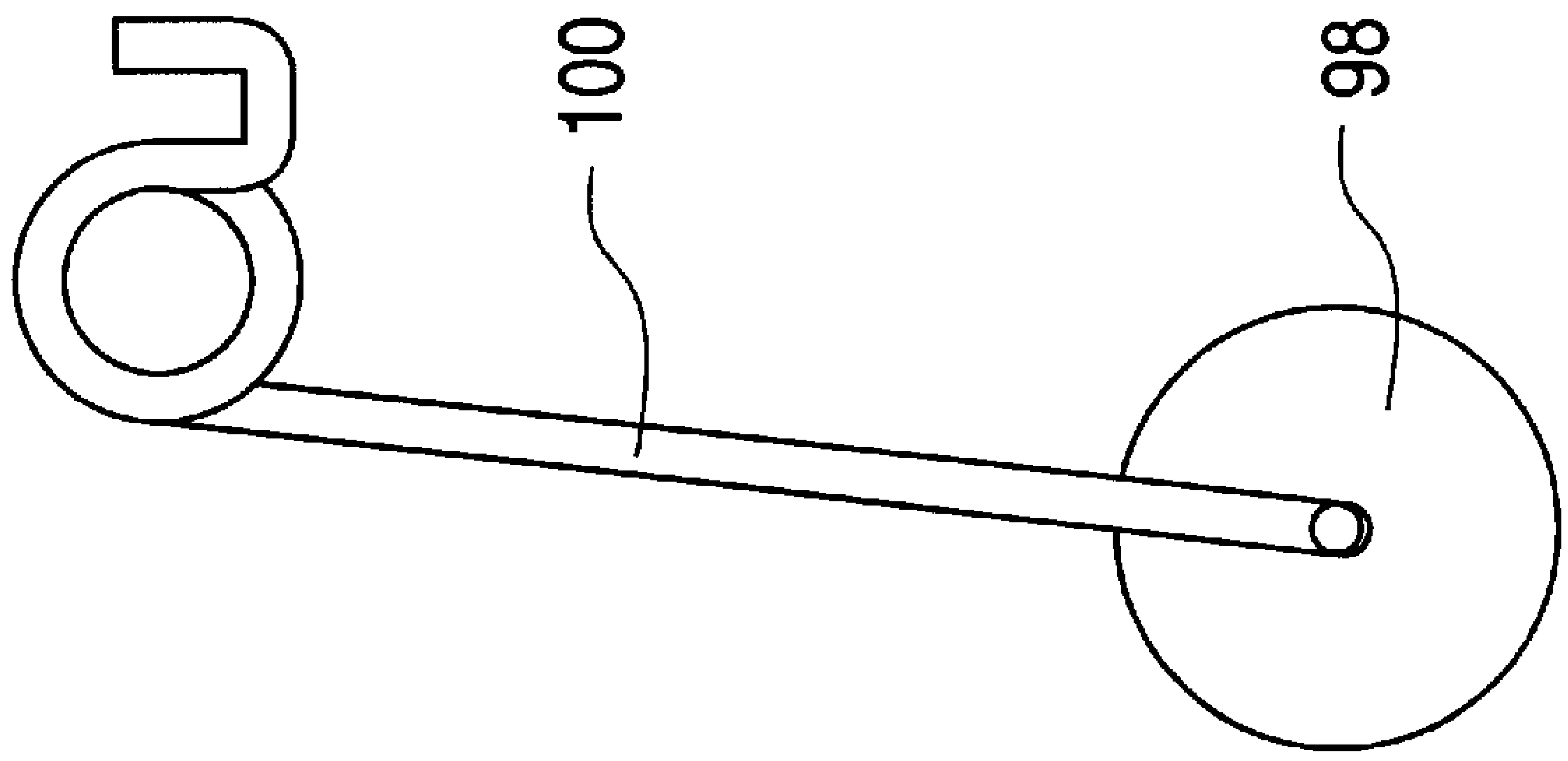

FIGURE 8B

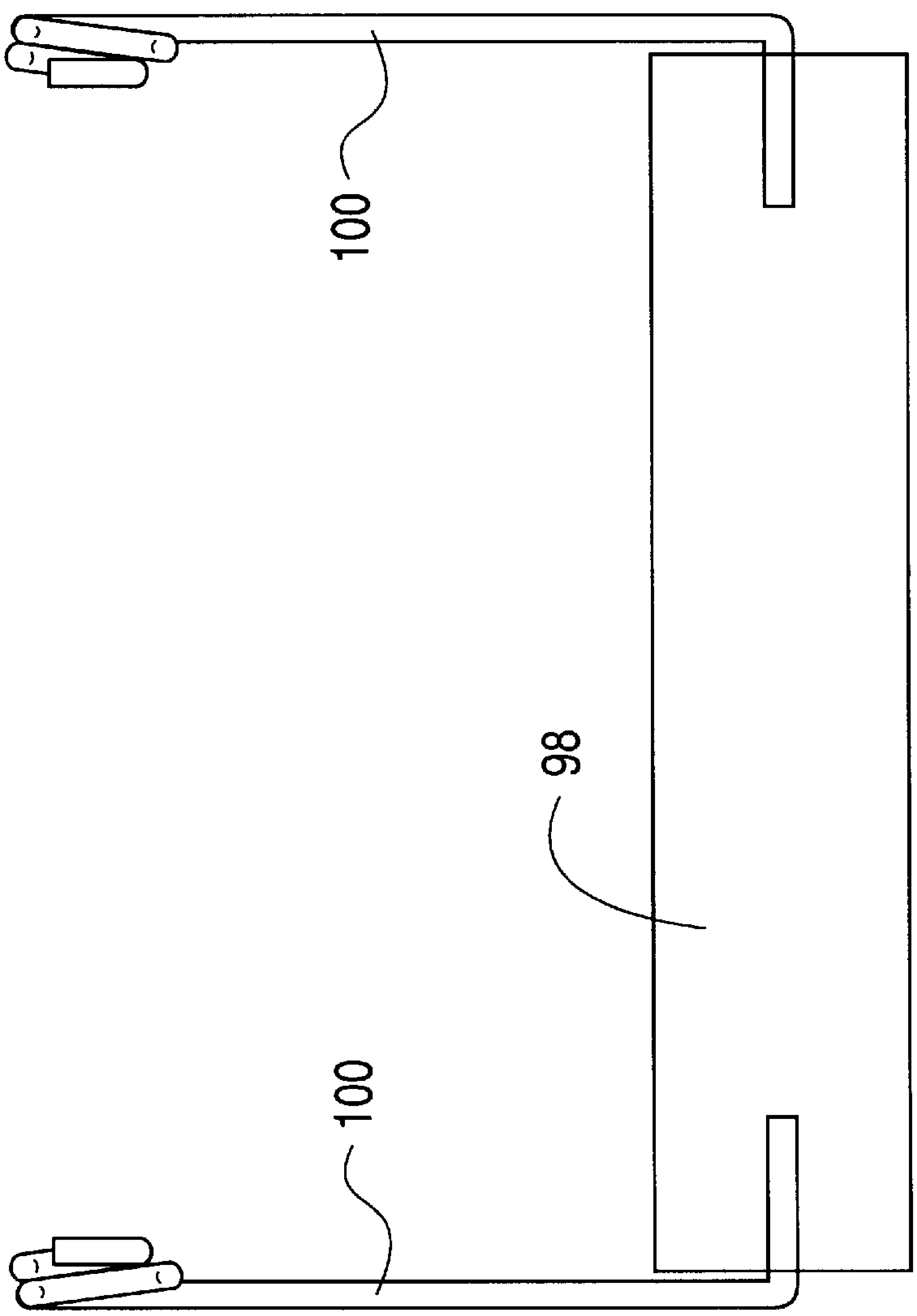

FIGURE 8A

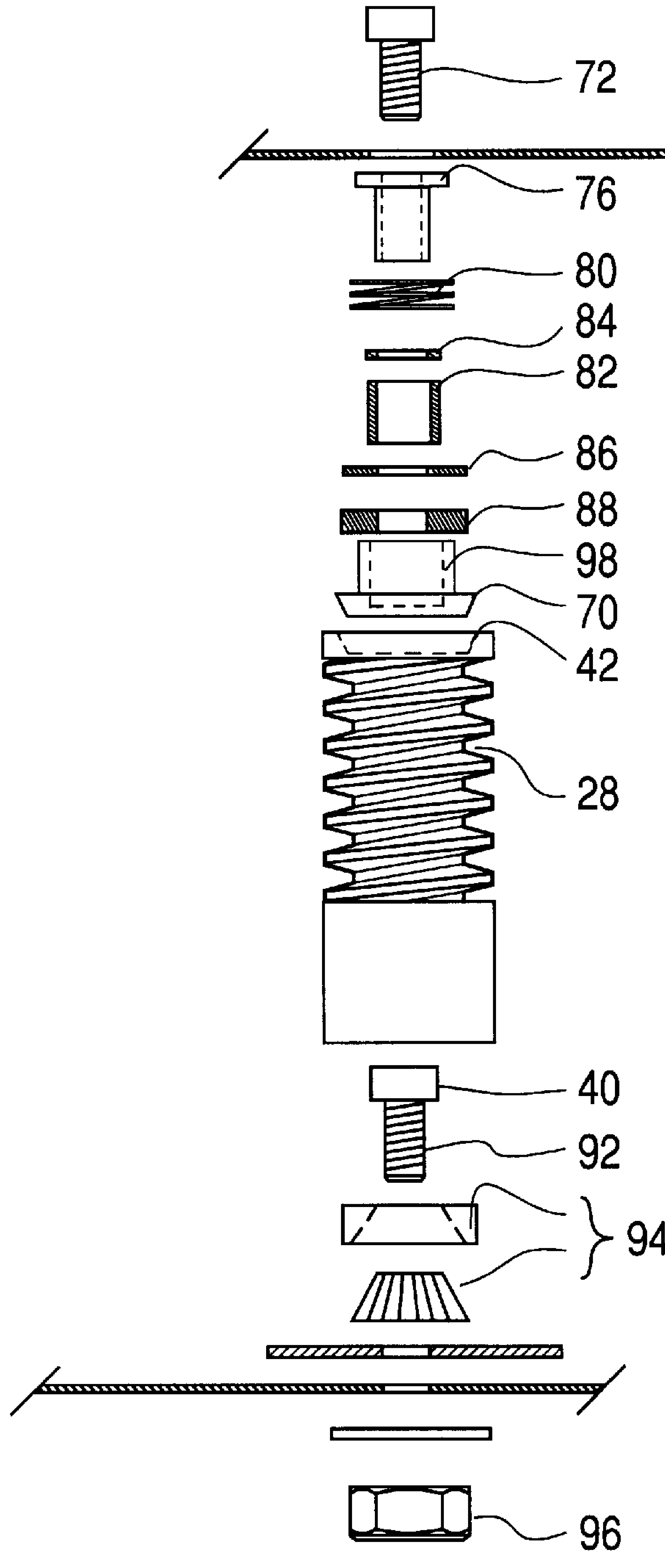

FIGURE 9

CHAINLESS DRIVE WINCH

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a winch. Especially this invention relates to a winch for lifting medium weight articles such as basketball backstops, or other gymnasium equipment.

2. Acknowledgement of Prior Art

Existing winches typically use belt or chain drives in conjunction with standard enclosed oil bath type worm drives. They tend to be bulky and heavy and require periodic adjustment of belts, etc. With extended use oil leaks can develop which is a hazard in gymnasium situations where oil may get on the floor.

With wear and polishing of the mating surfaces, even high ratio worn gears can "back-drive" under vibration conditions or when the inertia of the motor coupled with the dynamic lubrications affects the motion of the drum in the downward direction after the power has been shut-off.

Winches of the type described may utilize rope or wire cable or wire. The term "rope" will be used herein to encompass all normally used winch cables.

Rope anchorage is frequently a weak point on conventional winches. Sometimes the rope is secured with only two set screws clamping its end.

The limit switches on conventional winches are typically contrived as an add-on feature requiring shaft couplings and careful alignment.

Such switches are awkward to adjust accurately. Frequent problems occur when the rope either become slack on the cylinder and jumps out of the grooves where provided or does not track evenly across the cylinder creating undue wear on the rope and negating the setting of the limit switches. Moreover, the limit switches are difficult to adjust accurately.

The present inventors have addressed the problems connected with conventional winches.

SUMMARY OF THE INVENTION

The present invention provides a winch having a chainless and beltless drive comprising two drives orthogonally arranged one to the other on a one piece reduction gearing member. The reduction gearing member may conveniently be made from reinforced polymeric material. Such a one piece reduction gearing member may allow manufacture of a compact winch with drive integrity which may be improved over that of conventional winches. Moreover, the number of components is reduced in comparison with those of conventional winches thereby potentially reducing cost and labour in manufacture.

More particularly the invention provides a chainless drive winch comprising a cable cylinder rotatable about an elongate axis, the cylinder comprising a cable winding portion adapted to receive or dispense cable, and a worm gear wheel at one end; a reduction gearing member rotatable about an axis orthogonal to the cable cylinder, the reduction gearing member comprising a helical worm meshing with said worm gear wheel, and a driven worm gear wheel; and drive means having a helical drive worm on a drive shaft, the helical drive worm meshing with the driven worm gear wheel of the reduction gearing member. Additional reduction gearing may be provided through the helical drive worm with the driven worm gear wheel.

Preferably the cable winding portion and the worm gear wheel of the cable cylinder are integral with each other and may be cast metal, for example, aluminum, or molded from a self lubricating polymeric material such as filled nylon or polytetrafluoroethylene filled acetal.

The reduction gearing member may also be machined or molded in one piece from a metal or a self lubricating plastics material, such as filled nylon or polytetrafluoroethylene filled acetal.

Usually the drive means is an electric motor although for some small models there is no reason why a handle should not be provided for manual operation.

A pair of limit switches may be provided, the positions of which are adjustable to adjust the distance between them. A trigger is movable between the limit switches in dependence on an amount and direction of rotation of the rope cylinder, the trigger acting on each limit switch to alter operation of the electric motor to stop it. The movement of the trigger may be through a trigger gear wheel meshing with the worm gear at one end of the cable cylinder to drive a threaded shaft causing axial movement of a trigger nut on the shaft.

A brake may be provided on the reduction gearing member so that braking is not wholly dependent on stopping rotation of the cable cylinder which may be liable to back drive. A uni-directional clutch acts on the brake to allow unbraked rotation of the cable cylinder in one direction for a lifting operation and to brake rotation of the cable cylinder in another direction for lowering.

The brake may comprise an axial frustro-conical cavity in an upper end of the reduction gearing member, a brake cone held stationary to frictionally drag in said cavity to inhibit rotation of the reduction gearing member in one direction for lowering, and free to rotate to firmly engage in said cavity to allow rotation of the reduction gearing member in the other direction for lifting, and bearing means biasing said brake cone into said cavity; and the unidirectional clutch is operable on the bearing means to hold it stationary.

The cable winding portion of the cable cylinder preferably has helical grooves to locate cable. A roller may be provided generally parallel and adjacent the cable winding portion to bias cable into the helical grooves. The roller may be supported through independent torsion springs at each end portion to apply radial force to the roller to bias it towards the cable on the cable cylinder while allowing angular diversions from parallel so that, when cable is partially unwound from the cylinder bias will be preferentially exerted on the remaining turns of rope.

Preferably the winch includes a housing having opposed side walls, a top wall, a bottom wall and a front wall in which the cable cylinder is supported in bearings in the opposed side walls and the reduction gearing member is supported between the top and bottom walls, the side, top, bottom and front walls being located with respect to each other by tabs of the top and bottom walls locatable in corresponding slots of the side and front walls and tabs of the front wall locatable in notches in front vertical edges of the side walls. The bottom wall may be located above bottom edges of the side wall.

A further advantage may be that the drive system utilizes self-lubricating composite material eliminating the need for lubricating oil. As a result the winch may be installed in any orientation without concern for lubricant leakage.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention will now be described by way of example with reference to the drawings, in which:

FIG. 1 shows and isometric view of a winch according to the invention;

FIG. 2 shows a front view of the winch of FIG. 1;

FIG. 3 shows a side view of the winch as shown in FIG. 1;

FIG. 4 is a view from the side somewhat similar to FIG. 3 but viewed from within the housing showing operation components;

FIG. 5 is a simplified view of some of the essential working components of FIG. 4;

FIG. 6 is a view of the rope cylinder of the winch of the previous figures;

FIG. 7 is a view of the one piece molding reduction gearing member of the winch of the previous Figures;

FIGS. 8A and 8B show a view of a rope cylinder pressure roller for trapping rope in helical grooves of the rope cylinder; and

FIG. 9 shows an exploded view of the braking system for a winch as shown in the previous Figures.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The drawings show a winch **10** having a housing **12** and a electric motor **14**. The winch housing is constructed of accurately interlocking plates to maintain accurate geometry of the gears and other working parts. The plates have intermeshing tongues and slots to ensure precise assembly and to absorb a portion of the shear loads in the frame assembly. This permits lighter construction of the housing with no decrease in safety factor.

Rope **16** is usually led vertically onto a rope cylinder **18** through a top aperture **20** in which housing **12**. However, the winch housing **12** may be provided with front aperture **22** and an aperture at the rear so that rope **16** may be lead onto the rope cylinder from the front or the rear. These alternative directions for leading the rope onto the rope cylinder **18** are best seen in FIG. **4** where they are respectively labelled **16**A and **16**B.

The electric motor **14** has a drive shaft **24** extending into the winch housing **12**, a drive worm **26** is provided on the drive shaft.

Within the winch housing **12** a two-stage, one piece, single axle reduction gearing member **28** has a primary worm wheel **30** having parallel gear grooves at an angle to the axis and secondary helical worm **32** about the circumference of member **28**. Primary worm wheel **30** engages drive worm **26** of electric motor **14** which may be formed of porous impregnated Oilite (Trademark) bronze or of a self lubricating polymeric material and secondary worm **32** engages a worm wheel **34** on rope cylinder **18**. Reduction gearing member **28** may be machined or molded from Nylatron NSM (Trademark). It may, however, also be molded from other self-lubricating polymeric components such as Teflon (Trademark) filled acetal or filled nylon. Primary worm wheel **30** is provided as a series of axially angled gear grooves about an end portion of molded reduction gearing member **28**. The gear grooves of worm **30** engage teeth of drive worm **26**, the drive shaft of electric motor **14** extending at right angles to the axis of reduction gearing member **28**.

Secondary worm of reduction gearing member **28** comprises a helical gear groove about the body of reduction gearing member **28**. The helical gear groove of secondary worn **32** engages the worm wheel **34** of rope cylinder **18**, the axis of which is at right angles to the axis of reduction gearing member **28**. By this mechanism the rotation of electric motor **14** through drive shaft **24** is translated into rotation of rope cylinder **18** which is located at right angles to drive shaft **24**. This relative location of gearing is best seen from FIGS. **4** and **5**. In FIG. **5** the drive worm **26** is shown rotated through 90° for clarity although the actual position of the drive worm **26** is shown in dotted lines.

The reduction gearing member **28** has a cavity **36** in its lower end **38** for location on a bearing **40** on which reduction gearing member is freely rotatable.

Reduction gearing member **28** has frustro-conical cavity **42** in its upper end **44** for engagement with a brake cone as will be described hereinafter.

Rope cylinder **18** comprises a member either cast in metal, e.g. aluminum, or molded in one piece from reinforced self-lubricating material similar to that used to form the reduction gearing member **28**. In one end region of rope cylinder **18**, worm wheel **34** comprises a narrow cylindrical part having axial gear grooves **46** lying between gear ridges **48**. The body of the cylinder is provided with a helical groove **50** into which rope **16** is wound.

The operation of the winch thus far described is similar to the operation of conventional winches except for the one part construction of reduction gearing member **28** from self-lubricating material and the similar construction of rope cylinder **18**. When drive shaft **24** is rotated by means of electric motor **14**, drive worm **26** engages primary worm **30** of reduction gearing member **29** to rotate reduction gearing member **28** about its vertical axis as reduction gearing member **28** rotates about its vertical axis worm **34** of rope cylinder **18** engages with helical secondary worm **32** of reduction gearing member **28**. Thus rope cylinder **18** is caused to rotate about its horizontal axis at right angles to drive shaft **24**. As rope cylinder **18** rotates about its horizontal axis, rope **16** is wound onto the helical groove **50** thereof. The reduction gearing member **28** operates as reduction gearing between the electric motor and the rope cylinder **18**. The actual reduction is due to the angle of the gear grooves of worm **30** in respect to the axis of reduction gearing member **28**. The extent of the reduction gearing is dependent upon the loads on which the winch is to be used. The first stage may for example have 17 teeth on wheel **30** mated with a 3-start worm **26** to give a 17:3 (5.66:1) ratio. The second stage may have a ratio of 27:1 for a total of 153:1.

The rope cylinder **18** has a bearing projection at each end which bears in a bearing **52** of sidewalls of the housing **12**.

The winch features an improved limit switch arrangement. The limit switch drive provides 3 times more travel of the limit switch trip nut per foot of rope wound on or off, giving much improved accuracy of the limit adjustments.

A further improvement is gained by providing slidable adjustment of the actual limit switches in place of the usual adjustment of the position of the travelling nut(s). This is a much simplified and more accurate way of setting the stop positions.

A mechanism is provided for travel limit switch drive for the rope. Below the rope cylinder **18** and parallel with it is a threaded shaft **54** having a gear wheel **56** thereon. The gear wheel **56** meshes with worm wheel **34** of rope cylinder **18**. A threaded shaft **54** has end bearings **58** located in bearing apertures of the sidewalls of housing **12**. Threaded shaft **54** is rotated through meshing of drive wheel **56** with worm **34**. A travel nut **60** is provided on threaded shaft **54** which moves to and fro long the shaft in the one axial direction or the other on rotation of the shaft. A trip finger **62** depends from travel nut **60** to move between two limit switches may be altered by sliding the switch **64** in a slot in the base of the housing, thus reducing or increasing the amount of travel allowed of travel nut **60** before trip finger' **62** contacts switch **64** to switch off electric motor **14** to stop.

A braking system is provide which operates on the reduction gearing member **28** rather than relying solely on a negative reverse efficiency of a worm gear drive system. The pre-loaded brake is built into the reduction gearing member **28** to ensure positive stopping and holding of the member. A unidirectional clutch allows a brake cone to rotate with the drive pinion while running in the "up", or lifting, direction, but holds the brake cone stationary while lowering. The brake surface then generates frictional drag against the mating surface of the drive pinion, creating the required braking effect.

As has been described herein before, reduction gearing member **28** rotates on bearing **40** at its lower end. At its upper end reduction gearing member **28** is provided with an axial frustro-conical cavity **42**. In its unbraked condition, when driven by electric motor **14** to lift an article with the winch, reduction gearing member **28** and a brake cone **70** located fixedly in cavity **42** rotate together. When reduction gearing member **28** is driven in the opposite direction to lower the article, a conventional unidirectional clutch **82**, is operated to stop rotation of the brake cone **70**. There is now frictional drag between the surface of the brake cone **70** and the surface of the cavity **42** exerting a braking effect.

Operation of the brake is described with reference to FIG. **9**. A top bearing bolt **72** passes through an aperture in a top wall of housing **12** and screw threadedly engages an axial socket of a clutch pin **74** secured in clutch **82** against rotation in one direction while allowing rotation in the other direction. A coil spring **80** bears, on the one hand, against top wall of housing **12**. A washer **76** fits inside spring **80** to locate it and, on the other hand, against brake cone **70** through washer **86** and bearing **88**, biasing the brake cone **70** into engagement with reduction gearing member **28**.

The brake cone **70** is at all times in firm contact against cavity **42**, the force being supplied by the spring **80**. The spring does not rotate and the needle thrust (flat) bearing **88** allows the force to be applied without the spring rubbing against the brake cone. Therefore the top of member **28** is firmly guided by the radial bearing capacity of the brake clutch **82**. When electric motor **14** is operated to provide lifting, pin **74** slips in clutch socket **82** so that brake cone **70** and reduction gearing member **28** together turn in unbraked fashion powered by the motor. When electric motor **14** is operated to provide lowering, pin **74** engage clutch socket **82** so brake cone **70** drags frictionally in cavity **42** to provide braking.

Member **28** and brake cone **70** rotate together in "up" direction, therefore the brake cone provides firm radial support but no drag in "up" direction. In the "down" direction uni-directional clutch **82** locks onto pin **74**, holding brake cone **70** stationary and therefore provides braking torque via friction against the wall of cavity **42** while continuing to guide worm **28** radially.

FIG. **9** also shows in more detail the lower bearing **40** of reduction gearing member **48**. Lower bearing **40** comprises a bearing bolt **92** projecting through a tapered roller thrust bearing **94** and a washer flush with the lower surface of housing **12** and fixed by nut **96**.

FIGS. **8A** and **8B** shows a small diameter roller **98** located parallel with the body of rope cylinder **18**. The small diameter roller **98** has a length corresponding to the body of rope cylinder **18** having helical groove **50**. The roller **98** lies adjacent the helical groove **50** and traps rope in the helical grooves. The roller **98** has a resilient surface to enhance its action. The effectiveness of roller **98** is further enhanced by a pair of supporting torsion springs **100** which provide dual functions of both axles for roller **98** and a means of applying radial force to the roller **98**. At least torsion spring **100** at the end of helical groove **50** containing the distal end of rope **16** may be arranged to supply substantial radial force to the roller. The torsion springs **98** also allow the roller to move out of parallel to the cylinder axis, thereby tending to exert additional pressure on the last turn of the rope on the cylinder which in turn prevents any loosening of preceding turns. The end of the rope is passed through a hole in the wall of the cylinder and doubled back through a standard U-clamp which pulls up against the inside of the diameter of the cylinder **18**. Rope can not pull through this system and the radial force supplied by roller **98** enhances the security on the rope.

The rope cylinder **18** is supported in bearings **102** between sidewalls **104** in the housing **12** and member **28** is supported between top and bottom walls **106**, **108**. For free operation of the machinery it is extremely important that the location of the bearings are accurate and the housing parts fit accurately together. Downward forces due to the weight of articles to be lifted by the winch impose strains on the housing tending to distort it. To locate top wall **106** and bottom wall **108** accurately between sidewalls **104**, top and bottom walls are formed with tabs **110** to engage accurately stamped slots **112** in side walls **104**. The bottom wall **108** is located above the bottom edges **114** of side walls **104**. A front wall **116** is also provided having, on the one hand, sideways projecting tabs **118** fitting into notches **120** of the side walls **104**, and on the other hand slots **122** accepting tabs **124** of the bottom wall **108**. This interlocking system of tabs **110**, **118** and **124** with slots **112**, notches **120** and **122** respectively forms a firm interactive engagement between the walls **104**, **106** and **116** tending to counter the downward forces due to the action of the winch. Additional bolts may easily be inserted between flanges of the top and bottom walls and the side walls and front wall after accurate location of them through the tabs and slot system.

I claim:

1. A chainless drive winch comprising:

a cable cylinder rotatable about an elongate axis, the cylinder comprising a cable winding portion adapted to receive or dispense cable, integral with a worm gear at one end;

a reduction gearing member rotatable about a axis orthogonal to the cable cylinder, the reduction gearing member comprising a helical worm meshing with said worm gear, and a driven worm wheel;

drive means having a helical drive worm on a drive shaft, the helical drive worm meshing with the driven worm wheel of the reduction gearing; a brake on the reduction gearing member and a uni-directional clutch adapted to allow unbraked rotation of the cable cylinder in one direction for a lifting operation and adapted to brake rotation of the cable cylinder in another direction for lowering.

2. A chainless drive winch as claimed in claim **1** in which the brake comprises an axial frustro-conical cavity in an upper end of the reduction gearing member, a brake cone frictionally engaged in said cavity, a uni-directional clutch being provided to engage the brake cone stationary when the electric motor is operated in one direction whereby braking is provided due to frictional drag between said brake cone and said cavity and to allow the brake cone to rotate when the electric motor is operated in the other direction, whereby said brake cone rotates with the reduction gearing member.

3. A chainless drive winch as claimed in claim **1** in which the cable cylinder is cast metal.

4. A chainless drive winch as claimed in claim **1** in which the cable cylinder is molded from a self lubricating polymeric material selected from the group consisting of nylon and polytetrafluoroethylene filled acetal.

5. A chainless drive winch as claimed in claim **4** in which the reduction between said driven worm gear wheel and said helical worm is in the region of 27:1.

6. A chainless drive winch as claimed in claim **1** in which the reduction gearing member is molded or machined in one piece from a self lubricating plastics material selected from the group consisting of polytetrafluoroethylene filled acetal and nylon.

7. A chainless drive winch as claimed in claim **1** in which the drive means is an electric motor and including a pair of limit switches the positions of which are adjustable to adjust the distance between them, a trigger movable between the limit switches in dependence on an amount and direction of rotation of the rope cylinder, the trigger acting on each limit switch to alter operation of the electric motor.

8. A chainless drive winch as claimed in claim **7** in which the trigger is movable through a trigger gear wheel meshing with the worm gear at one end of the cable cylinder.

9. A chainless drive winch as claimed in claim **1** in which the cable winding portion of the cable cylinder has helical grooves to locate cable, and in which is provided a roller generally parallel and adjacent the cable winding portion to bias cable into the helical grooves.

10. A chainless drive winch as claimed in claim **9** in which the roller is supported through torsion springs at each end portion to apply radial force to the roller while allowing angular diversion from parallel.

11. A chainless drive winch comprising:

a cable cylinder rotatable about an elongate axis, the cylinder comprising a cable winding portion adapted to receive or dispense cable, integral with a worm gear at one end;

a reduction gearing member rotatable about a axis orthogonal to the cable cylinder, the reduction gearing member comprising a helical worm meshing with said worm gear, and a driven worm wheel; and

a housing having opposed side walls, a top wall, a bottom wall and a front wall, in which the cable cylinder is supported in bearings in the opposed side walls and the reduction gearing member is supported between the top and bottom walls, the side, top, bottom and front walls being located with respect to each other by tabs of the top and bottom walls locatable in corresponding slots of the side and front walls and tabs of the front wall locatable in notches in front vertical edges of the side walls.

12. A chainless drive as claimed in claim **11** in which the bottom wall is located above bottom edges of the side walls.

13. A chainless drive winch as claimed in claim **11** in which the cable cylinder is cast metal.

14. A chainless drive winch as claimed in claim **11** in which the cable cylinder is molded from a self lubricating polymeric material selected from the group consisting of nylon and polytetrafluoroethylene filled acetal.

15. A chainless drive winch as claimed in claim **11** in which the reduction gearing member is moulded or machined in one piece from a self lubricating plastics material selected from the group consisting of polytetrafluoroethylene filled acetal and nylon.

16. A chainless drive winch as claimed in claim **15** in which the reduction between said driven worm gear wheel and said helical worm is in the region of 27:1.

17. A chainless drive winch as claimed in claim **11** in which the drive means is an electric motor and including a pair of limit switches the positions of which are adjustable to adjust the distance between them, a trigger movable between the limit switches in dependence on an amount and direction of rotation of the rope cylinder, the trigger acting on each limit switch to alter operation of the electric motor.

18. A chainless drive winch as claimed in claim **17** in which the trigger is movable through a trigger gear wheel meshing with the worm gear at one end of the cable cylinder.

19. A chainless drive wheel as claimed in claim **11** in which the cable winding portion of the cable cylinder has helical grooves to locate cable, and in which is provided a roller generally parallel and adjacent the cable winding portion to bias cable into the helical grooves.

20. A chainless drive winch as claimed in claim **19** in which the roller is supported through torsion springs at each end portion to apply radial force to the roller while allowing angular diversion from parallel.

* * * * *